

PATENT ABSTRACTS OF JAPAN

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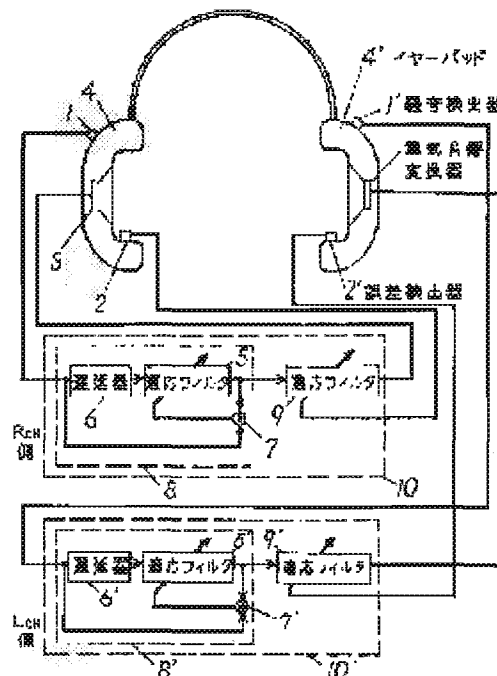
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(54) NOISE CONTROLLER

(57)Abstract:

PURPOSE: To provide a system of feedforward constitution by utilizing an adaptive filter as a means for stable periodic noise control when the noise control is performed by using active noise control in noise environment.

CONSTITUTION: The noise controller consists of ear pads 4 and 4' which are installed covering the Lch-side and Rch-side ears, noise detectors 1 and 1' which are installed outside the ear pads and detect noises nearby them, electroacoustic transducers 3 and 3' which are installed inside the ear pads 4 and 4', error detectors 2 and 2' which detect errors between a sounds reaching the inside of the ear pads and the sounds from the electroacoustic transducers, periodic signal extracting circuits 8 and 8' which extract only the periodic signals from the noise detectors 1 and 1', and adaptive filters 9 and 9' which perform adaptive control over the periodic signals.



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CLAIMS

[Claim(s)]

[Claim 1] An ear pad installed so that an ear by the side of Lch and Rch might be covered respectively and it might seal, Noise detectors which are installed in the outside of said ear pad and detect noise near said ear pad, An error detector which detects an error of an electroacoustic transducer installed inside said ear pad, a sound which is installed inside said ear pad and reaches inside said ear pad, and a sound from said electroacoustic transducer, A noise control device consisting of a cyclic signal extracting circuit which extracts a cyclic signal out of a signal detected from said noise detectors, and an adaptation filter which carries out the adaptive control of said cyclic signal.

[Claim 2] A noise control device comprising:

An ear pad installed so that an ear by the side of Lch and Rch might be covered respectively and it might seal.

Noise detectors which are installed in the outside of said ear pad and detect noise near said ear pad.

An error detector which detects an error of a sound which is installed inside said ear pad and reaches inside said ear pad, and a sound from said electroacoustic transducer.

A cyclic signal extracting circuit which extracts a cyclic signal out of a signal detected from said noise detectors, An adaptation filter which carries out the adaptive control of said cyclic signal, and an output of said adaptation filter and an adding machine adding a sound and signal transmission from a microphone etc., A subtractor which subtracts an output of said digital disposal circuit from an electroacoustic transducer which an output of said adding machine was reproduced and was installed inside said ear pad, a digital disposal circuit which controls said sound and signal transmission, and a signal detected with said error detector, and controls said adaptation filter and a digital disposal circuit.

[Claim 3]The noise control device according to claim 2, wherein a digital disposal circuit is the digital filter which approximated a transfer function from an adding machine to an error detector.

[Claim 4]The noise control device according to claim 2, wherein an adaptation filter identified by comprising an adaptation filter and a switch and switching an output of a subtractor with said switch is made as for a digital disposal circuit to immobilization.

[Claim 5]The noise control device according to claim 2, wherein an adaptation filter is adapted so that a signal from a subtractor may serve as the minimum.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the noise control device which used active noise control, in order to perform protection and clear communication of the ear in noise environment.

[0002]

[Description of the Prior Art]The noise control device using the conventional year protector had common composition as shown in JP,63-503186,A. Hereafter, it explains, referring to (drawing 3) for the composition. As shown in (drawing 3), the circuit which returns from the microphone 15 installed in the ear pad 14 to the input of the microphone 15 via the amplifier 12, the analog filter 13, and the electroacoustic transducer 11 constitutes the feedback loop. The composite tone pressure of the noise which advances from the outside of an ear pad, and the sound outputted from an electroacoustic transducer, The high profit of the amplifier 12 is taken and sound pressure decreases by setting the characteristic of the analog filter 13 as the transfer function which carries out equivalence of the open loop transfer function from the electroacoustic transducer 11 to the microphone 15.

[0003]

[Problem(s) to be Solved by the Invention]However, since the feedback loop is constituted from above-mentioned composition, howling by resonance may occur when designing an equivalent filter, In order to avoid howling, it must constitute from a band pass filter, and it becomes difficult to attenuate the noise of comparatively a high region.

[0004]This invention solves the above-mentioned problem, and does not constitute the feedback loop, but provides the noise control device which enabled clear transmission of the stable noise control and sound of periodicity noise, or signal transmission in an ear pad.

[0005]

[Means for Solving the Problem]This invention comprises:

an ear pad installed so that an ear of (1) of each L and R might be covered and it might seal as composition which does not constitute the feedback loop, in order to solve the above-mentioned problem.

Noise detectors which are installed in the outside of said ear pad and detect noise near said ear pad.

An electroacoustic transducer installed inside said ear pad.

An error detector which detects an error of a sound which is installed inside said ear pad and reaches inside said ear pad, and a sound from said electroacoustic transducer, A cyclic signal extracting circuit which extracts a cyclic signal out of a signal detected from said noise detectors, with an ear pad installed so that an ear by the side of adaptation filters (2) of each Lch which carry out adaptive control, and Rch might be covered and said cyclic signal might be sealed. Noise detectors which are installed in the outside of said ear pad and detect noise near said ear pad, An error detector which detects an error of a sound which is installed inside said ear pad and reaches inside said ear pad, and a sound from said electroacoustic transducer, A cyclic signal extracting circuit which extracts a cyclic signal out of a signal detected from said noise detectors, An adaptation filter which carries out the adaptive control of said cyclic signal, and an output of said adaptation filter and an adding machine adding a sound and signal transmission from a microphone etc., A subtractor which subtracts an output of said digital disposal circuit from an electroacoustic transducer which an output of said adding machine was reproduced and was installed inside said ear pad, a digital disposal circuit which controls said sound and signal transmission, and a signal detected with said error detector, and controls said adaptation filter and a digital disposal circuit.

[0006]

[Function]This invention detects the noise signal from the outside of an ear pad, and extracts a cyclic signal out of a noise signal, An adaptation filter is controlled in order to attenuate the periodicity noise within an ear pad, and stable noise control within an ear pad is realized, without constituting the feedback loop from carrying out convolution arithmetic operation of the noise signal.

[0007]In order to transmit a sound and signal transmission with sufficient S/N, the signal detected with the error detector is made only into a noise signal with a subtractor, Adaptation is carried out so that the periodicity noise detected with noise detectors by making this into the control signal of an adaptation filter may be decreased within an ear pad, if it is added with a sound and signal transmission and reproduces from an electroacoustic transducer, the periodicity noise in an ear pad will decrease and good transmission of S/N will be attained.

[0008]

[Example] Hereafter, the example of this invention is described using a drawing.

[0009] One example of this invention is shown in (drawing 1). In (drawing 1), 1 and 1' in noise detectors, and 2 and 2' An error detector, 3 and 3' -- an electroacoustic transducer, and 4 and 4' -- it is [a periodicity detector circuit, and / 9 and 9' / an adding machine, and / 8 and 8' / a delay device, and / 7 and 7' / an adaptation filter, and / 6 and 6' / an ear pad, and / 5 and 5'] a noise control circuit in an adaptation filter, and 10 and 10'.

[0010] First, both ears are covered in the ear pads 4 and 4' of each left-hand side (it carries out abbreviated to the following Lch side), and right-hand side (it carries out abbreviated to the following Rch side), and it holds so that both ears may be sealed. The noise detectors 1 detect the noise signal which advanced from the outside of the ear pad 4, it is inputted into the periodicity detector circuit 8, convolution arithmetic operation is performed by the internal adaptation filter 9 after that, and this noise signal is pronounced by ear pad 4 inside with the electroacoustic transducer 3. Noise signal in time t (however, i integer from 0 to tap-numbers n) $x(t)$ and error signal $e(t)$ If the coefficient of each present tap of the adaptation filter 9 is set to $h(i, t)$, If the coefficient $h(i, t+1)$ in time $(t+1)$ shows the algorithm of coefficient renewal, it is $h(i, t+1) = h(i, t) + \mu \cdot e(t) \cdot x(t-i) \dots (1)$

It is come out and expressed. μ is the number of $0 < \mu < 1$ by a convergence constant here. The coefficient of the adaptation filter 9 is converged so that error signal $e(t)$ may become the minimum. The error detector 2 decreases a periodicity noise signal by ear pad 4 inside in order to detect the difference of the sound which reaches inside an ear pad, and the sound from the electroacoustic transducer 3 from the exterior as error signal $e(t)$.

[0011] Here, the cyclic signal extracting circuit 8 comprises the delay device 6, the adaptation filter 5, and the adding machine 7 like (drawing 1). Since the delay device 6 is passed in this composition, processing of an irregularity signal stops meeting the deadline, and the adaptation filter 5 cannot be controlled, but the output of the adaptation filter 5 becomes only a cyclic signal as a result. The return signal which the sound which the electroacoustic transducer 3 pronounces exerts on the noise detectors 1 serves as a sufficiently small value from the direction of the energy emitted to an inside from the exterior becoming large compared with the energy emitted to the exterior from the inside of an ear pad. That is, the feedback gain from the electroacoustic transducer 3 to the noise detectors 1 becomes low enough. Therefore, as noise control, the feedback loop is not formed but serves as feedforward processing. In this example, although only explanation of operation by the side of Rch was given, since the same may be said of the Lch side, the detailed explanation is omitted.

[0012] Next, the 2nd example of this invention is described using (drawing 2). the same noise control circuit as the 1st example represented with an adaptation filter 10 in (drawing 2), and 20 -- as for a power amplifier and 24, a sending set and 22 are [a subtractor and 26] switches

an adaptation filter and 25 an adding machine and 23 the microphone for communication, and 21. Since operation with the same Rch side and Lch side is performed also in this example, only channel of one of the two is explained.

[0013]The state where there is almost no noise is considered. The switch 26a is turned OFF, the switch 26b is turned ON, and ***** operates the sending set 21 which emits signal transmission. As for ***** uttered from this sending set 21, signal transmission is reproduced from the electroacoustic transducer 3 through the adding machine 22 and the power amplifier 23. The signal reproduced in the ear pad is inputted into the subtractor 25 by the error detector 2 (microphone). On the other hand, signal transmission is inputted also into the adaptation filter 24, and, as for ***** uttered from the sending set 21, the output is inputted into the subtractor 25. The adaptation filter 24 is adapted here so that the output from the subtractor 25 may decline.

[0014]Next, signal transmission is stopped, the switch 26a is turned ON, it turns OFF the switch 26b, and said ***** installs it under a noise condition. After an outside noise is detected and being adjusted with the adaptation filter 10 by the noise detectors 1, it is reproduced with the electroacoustic transducer 3 via the adding machine 22 and the power amplifier 23. This reproduced signal is detected with the error detector 2, and turns into a control signal of the adaptation filter 10 via the subtractor 25. Adaptation of this adaptation filter 10 is carried out so that a control signal may be attenuated. When the above adjustment is completed, ***** uttered from the sending set 21 operates signal transmission, and makes the switches 26a and 26b turn on. By this, the ***** can attenuate only a periodicity noise signal in the ear pad in which signal transmission and a periodicity noise signal are intermingled. If the exterior of the ear pad 4 is equipped with the microphone 20 for transmission as shown in (drawing 2), an ear pad wearing person will become possible [also transmitting to other parts].

[0015]

[Effect of the Invention]The noise control device of feed-forward control which the periodicity invasion noise from the outside decreases this invention with an adaptation filter in the space in an ear pad, and does not form the feedback loop is realized as mentioned above. Since the periodicity noise in an ear pad declines, the noise eraser which a sound and signal transmission with other parts can improve the receiving and sending of the S/N can be provided.

[Translation done.]

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TECHNICAL FIELD

[Industrial Application] This invention relates to the noise control device which used active noise control, in order to perform protection and clear communication of the ear in noise environment.

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PRIOR ART

[Description of the Prior Art]The noise control device using the conventional year protector had common composition as shown in JP,63-503186,A. Hereafter, it explains, referring to (drawing 3) for the composition. As shown in (drawing 3), the circuit which returns from the microphone 15 installed in the ear pad 14 to the input of the microphone 15 via the amplifier 12, the analog filter 13, and the electroacoustic transducer 11 constitutes the feedback loop. The composite tone pressure of the noise which advances from the outside of an ear pad, and the sound outputted from an electroacoustic transducer, The high profit of the amplifier 12 is taken and sound pressure decreases by setting the characteristic of the analog filter 13 as the transfer function which carries out equivalence of the open loop transfer function from the electroacoustic transducer 11 to the microphone 15.

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EFFECT OF THE INVENTION

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, since the feedback loop is constituted from above-mentioned composition, howling by resonance may occur when designing an equivalent filter, In order to avoid howling, it must constitute from a band pass filter, and it becomes difficult to attenuate the noise of comparatively a high region.

[0004]This invention solves the above-mentioned problem, and does not constitute the feedback loop, but provides the noise control device which enabled clear transmission of the stable noise control and sound of periodicity noise, or signal transmission in an ear pad.

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MEANS

[Means for Solving the Problem]This invention comprises:

an ear pad installed so that an ear of (1) of each L and R might be covered and it might seal as composition which does not constitute the feedback loop, in order to solve the above-mentioned problem.

Noise detectors which are installed in the outside of said ear pad and detect noise near said ear pad.

An electroacoustic transducer installed inside said ear pad.

An error detector which detects an error of a sound which is installed inside said ear pad and reaches inside said ear pad, and a sound from said electroacoustic transducer, A cyclic signal extracting circuit which extracts a cyclic signal out of a signal detected from said noise detectors, with an ear pad installed so that an ear by the side of adaptation filters (2) of each Lch which carry out adaptive control, and Rch might be covered and said cyclic signal might be sealed. Noise detectors which are installed in the outside of said ear pad and detect noise near said ear pad, An error detector which detects an error of a sound which is installed inside said ear pad and reaches inside said ear pad, and a sound from said electroacoustic transducer, A cyclic signal extracting circuit which extracts a cyclic signal out of a signal detected from said noise detectors, An adaptation filter which carries out the adaptive control of said cyclic signal, and an output of said adaptation filter and an adding machine adding a sound and signal transmission from a microphone etc., A subtractor which subtracts an output of said digital disposal circuit from an electroacoustic transducer which an output of said adding machine was reproduced and was installed inside said ear pad, a digital disposal circuit which controls said sound and signal transmission, and a signal detected with said error detector, and controls said adaptation filter and a digital disposal circuit.

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OPERATION

[Function]This invention detects the noise signal from the outside of an ear pad, and extracts a cyclic signal out of a noise signal, An adaptation filter is controlled in order to attenuate the periodicity noise within an ear pad, and stable noise control within an ear pad is realized, without constituting the feedback loop from carrying out convolution arithmetic operation of the noise signal.

[0007]In order to transmit a sound and signal transmission with sufficient S/N, the signal detected with the error detector is made only into a noise signal with a subtractor, Adaptation is carried out so that the periodicity noise detected with noise detectors by making this into the control signal of an adaptation filter may be decreased within an ear pad, if it is added with a sound and signal transmission and reproduces from an electroacoustic transducer, the periodicity noise in an ear pad will decrease and good transmission of S/N will be attained.

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EXAMPLE

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[0010] First, both ears are covered in the ear pads 4 and 4' of each left-hand side (it carries out abbreviated to the following Lch side), and right-hand side (it carries out abbreviated to the following Rch side), and it holds so that both ears may be sealed. The noise detectors 1 detect the noise signal which advanced from the outside of the ear pad 4, it is inputted into the periodicity detector circuit 8, convolution arithmetic operation is performed by the internal adaptation filter 9 after that, and this noise signal is pronounced by ear pad 4' inside with the electroacoustic transducer 3. Noise signal in time t (however, i integer from 0 to tap-numbers n) $x(t)$ and error signal $e(t)$ If the coefficient of each present tap of the adaptation filter 9 is set to $h(i, t)$, If the coefficient $h(i, t+1)$ in time $(t+1)$ shows the algorithm of coefficient renewal, it is $h(i, t+1) = h(i, t) + \mu e(t) \cdot x(t-i) \dots (1)$

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The lineblock diagram of the noise control device which is the 1st example of this invention

[Drawing 2] The lineblock diagram of the noise control device which is the 2nd example of this invention

[Drawing 3] The lineblock diagram of the conventional noise control device

[Description of Notations]

1 and 1' noise detectors

2 and 2' error detector

3 and 3' electroacoustic transducer

4 and 4' ear pad

the [5 and 5'] -- the adaptation filter of one

6 and 6' delay device

7 and 7' adding machine

8 and 8' cyclic signal extracting circuit

the [9 and 9'] -- the adaptation filter of two

10 and 10' noise control circuit

20 The microphone for transmission

21 A device for transmission

22 Adding machine

23 Power amplifier

24 The 3rd adaptation filter

25 Subtractor

26a and 26b Switch

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cyclic signal as a result. The return signal which the sound which the electroacoustic transducer 3 pronounces exerts on the noise detectors 1 serves as a sufficiently small value from the direction of the energy emitted to an inside from the exterior becoming large compared with the energy emitted to the exterior from the inside of an ear pad. That is, the feedback gain from the electroacoustic transducer 3 to the noise detectors 1 becomes low enough. Therefore, as noise control, the feedback loop is not formed but serves as feedforward processing. In this example, although only explanation of operation by the side of Rch was given, since the same may be said of the Lch side, the detailed explanation is omitted.

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[0014]Next, signal transmission is stopped, the switch 26a is turned ON, it turns OFF the switch 26b, and said ***** installs it under a noise condition. After an outside noise is detected and being adjusted with the adaptation filter 10 by the noise detectors 1, it is reproduced with the electroacoustic transducer 3 via the adding machine 22 and the power amplifier 23. This reproduced signal is detected with the error detector 2, and turns into a control signal of the adaptation filter 10 via the subtractor 25. Adaptation of this adaptation filter 10 is carried out so that a control signal may be attenuated. When the above adjustment is completed, ***** uttered from the sending set 21 operates signal transmission, and makes the switches 26a and 26b turn on. By this, the ***** can attenuate only a periodicity noise signal in the ear pad in which signal transmission and a periodicity noise signal are intermingled. If the exterior of the ear pad 4 is equipped with the microphone 20 for transmission as shown in (drawing 2), an ear pad wearing person will become possible [also transmitting to other parts].

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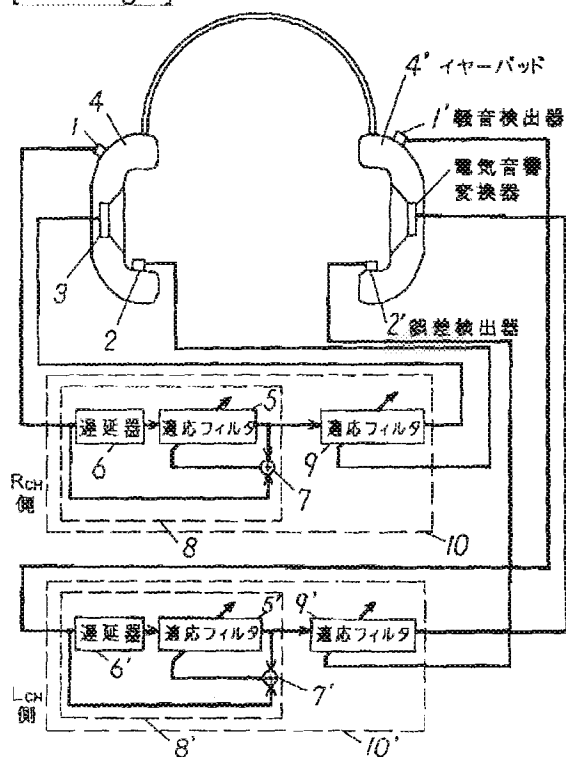
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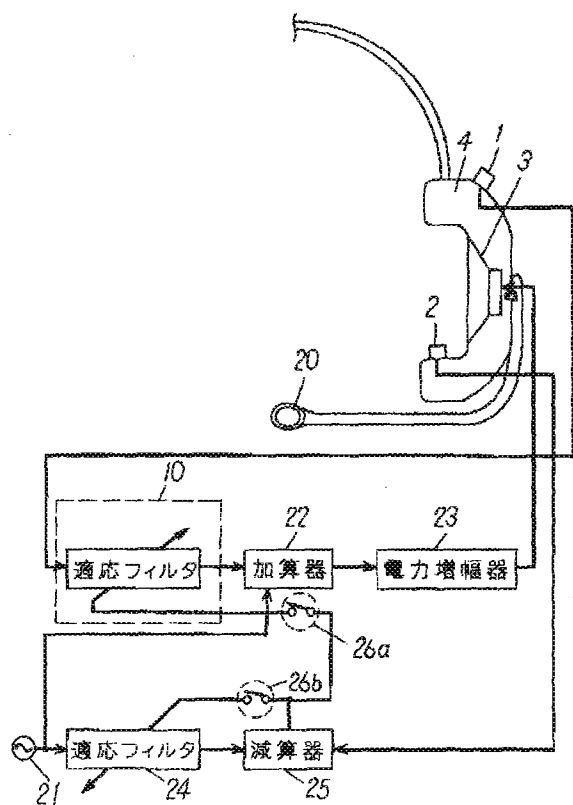
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DRAWINGS

[Drawing 1]

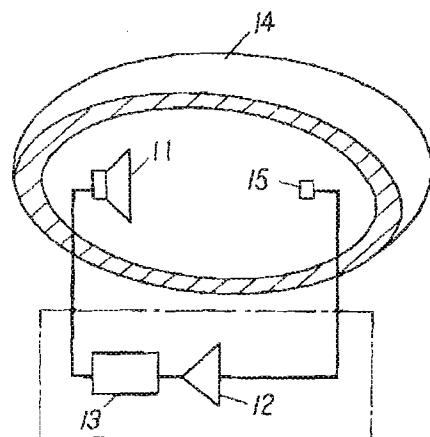


[Drawing 2]



[Drawing 3]

- 11 電気音響変換器
- 12 増幅器
- 13 アナログフィルター
- 14 イヤーパッド
- 15 マイクロフォン



[Translation done.]